1. A composite material assembly for reversibly transferring a gaseous element comprising:

a base-material at least partially coated with a catalyst and at least partially permeable to the gaseous element and defining at least one hollow region for containing the gaseous element.

2. The composite material of claim 1 wherein transferring the gaseous element comprises releasing and/or storing the gaseous element.

3. The composite material assembly of claim 1 wherein the catalyst comprises at least one of nickel, palladium, silver, platinum, copper, gold, titanium, silicon, iron, aluminum, indium, gallium, niobium, tantalum, vanadium, molybdenum, tungsten, zirconium, cobalt, chromium, carbon, cadmium, beryllium, rhenium, rhodium, rubidium, or alloys thereof.

4. The composite material assembly of claim 1 wherein a plurality of composite material assemblies are at least one of sintered or welded together.

5. The composite material assembly of claim 1 wherein the base-material has a size range of between 5 and 5000 microns.

6. The composite material assembly of claim 1 wherein the base-material comprises a microbubble.

7. The composite material assembly of claim 6 wherein the microbubble has a diameter size range between 5 and 5000 microns.

8. The composite material assembly of claim 6 wherein the microbubble has a wall thickness range between 0.10 and 100 microns.

9. The composite material assembly of claim 1 further comprising at least one of aluminum, silicon, zirconium, carbon, and boron.

10. The composite material assembly of claim 1 wherein the base-material comprises a glass.

11. The composite material assembly of claim 10 wherein the glass comprises at least one of vitreous silica, vitreous germania, vitreous boric oxide, titanium silicate, aluminosilicate, alkali silicate, alkaline earth silicate, alkaline earth germinate, alkali borate, borosilicate, alkali aluminosilicate, alkali galliosilicate, soda-lime silicate, alkali borosilicate, phosphate, natural, and commercial.

12. The composite material assembly of claim 1 wherein the base-material comprises a glass-ceramic.

13. The composite material assembly of claim 12 wherein the glass-ceramic comprises a microbubble.

14. The composite material assembly of claim 12 wherein the glass-ceramic comprises at least one of lithium aluminosilicate, lithium silicate, lithium metasilicate, lithium disilicate, zinc silicate, and commercial.

15. The composite material assembly of claim 1 wherein the base-material comprises a ceramic.

16. The composite material assembly of claim 14 wherein the ceramic comprises a microbubble.

17. The composite material assembly of claim 15 wherein the ceramic comprises at least one of alumina, zirconia, yttria, silica alumina, mullite, sillimanite, porcelain, and a polycrystalline material.

18. The composite material assembly of claim 1 wherein the coating is formed by a coating process including at least one of chemical vapor deposition, electroplating, electroless plating, sol gel, plasma-activated chemical vapor deposition, sputtering, and painting.

19. The composite material assembly of claim 1 wherein the permeability is controllably altered by at least one of pressure and temperature.

20. The composite material assembly of claim 1 wherein a rate of transfer of the gaseous element is enhanced by surface modifications to the coating.

21. An electrode for reversibly transferring a gaseous element, comprising:

a plurality of composite material assemblies each comprising an at least partially catalyst-coated base-material, the base-material at least partially permeable to the gaseous element and defining at least one hollow region for containing the gaseous element, wherein the plurality of composite material assemblies is at least partially electrically interconnected.

22. The electrode of claim 21 further comprising a hydrogen-absorbing material interspersed therewith.

23. The electrode of claim 22 wherein the hydrogen-absorbing material comprises a metal hydride.

24. The electrode of claim 21 wherein the catalyst coating comprises at least one of nickel, palladium, silver, platinum, copper, gold, titanium, silicon, iron, aluminum, indium, gallium, niobium, tantalum, vanadium, molybdenum, tungsten, zirconium, cobalt, chromium, carbon, cadmium, beryllium, rhenium, rhodium, rubidium, or alloys thereof.

25. The electrode of claim 21 wherein the plurality of composite material assemblies are at least one of sintered or welded together.

26. The electrode of claim 21 wherein the composite material assemblies are combined to form a non-sintered matrix.

27. The electrode of claim 21 wherein the gaseous element is hydrogen.

28. The electrode of claim 21 wherein the gaseous element is oxygen.

29. An apparatus for transferring a gaseous element, comprising:

a plurality of composite material assemblies including an at least partially catalyst-coated base-material, the base-material being at least partially permeable to the gaseous element and defining at least one hollow region for storage of the gaseous element, the plurality of composite material assemblies at least partially electrically interconnected;

an electrolyte comprising the gaseous element; and

a power module in electrical communication with the plurality of composite material assemblies, wherein induced electrochemical reactions involving the gaseous element, the catalyst, the power module, and the electrolyte cause the gaseous element to either accumulate in or be liberated from the hollow region.

30. The apparatus of claim 29 further comprising:

a pressurizeable environment, wherein a pressure of the gaseous element within the pressurizeable environment is periodically adjusted such that the gaseous element accumulates in or is liberated from the hollow region.

31. The apparatus of claim 29 wherein the base-material is at least partially permeable to hydrogen.

32. The apparatus of claim 29 wherein the gaseous element is hydrogen.

33. The apparatus of claim 29 wherein the apparatus is an electrochemical half-cell.

34. The apparatus of claim 29 wherein the gaseous element is oxygen.

35. The apparatus of claim 29 wherein the transfer of the gaseous element is enhanced by chemical additions to the electrolyte.

36. A gaseous storage rechargeable electrochemical cell comprising:

a housing;

an electrolyte disposed in the housing and comprising a first gaseous element;

a first electrode disposed within the housing and in contact with the electrolyte, wherein the first electrode comprises a plurality of composite material assemblies, each assembly comprising an at least partially catalyst-coated base-material at least partially permeable to the first gaseous element and defining at least one first hollow region for storage of the

first gaseous element, the plurality of assemblies at least partially electrically interconnected; and

a power module in at least partial electrical communication with the plurality of composite material assemblies, such that induced electrochemical reactions at the first electrode involving the first gaseous element, the catalyst, the power module, and the electrolyte, cause the first gaseous element to either accumulate in or be liberated from the first hollow region.

37. The electrochemical cell of claim 36 further comprising:

a second electrode disposed within the housing in a spaced relationship relative to the first electrode, the second electrode comprising a second plurality of composite material assemblies, each comprising an at least partially catalyst-coated base-material at least partially permeable to a second gaseous element and defining at least one second hollow region for storage of the second gaseous element, the second plurality of assemblies at least partially electrically interconnected; and

a power module in at least partial electrical communication with the second plurality.

38. The electrochemical cell of claim 36 wherein the first gas is hydrogen.

39. The electrochemical cell of claim 37 the second gas is oxygen.

40. The electrochemical cell of claim 37 wherein the electrochemical cell is a rechargeable battery.

41. The electrochemical cell of claim 36 wherein the first electrode comprises a mixture including nickel as a major component, the mixture disposed on an at least partially electrically conductive interconnected substrate that is in at least partial electrical communication with the power module.

42. The electrochemical cell of claim 37 wherein the second electrode comprises a mixture including nickel as a major component, the mixture disposed on an at least partially electrically

conductive interconnected substrate that is in at least partial electrical communication with the power module.

43. The electrochemical cell of claim 37 wherein the second electrode comprises:

a oxygen electrode disposed within the housing in a spaced relationship relative to the first electrode and the housing, the positive oxygen electrode on one side being exposed through an electrolyte to the first electrode and on the opposite side to gaseous oxygen through a supply port in the housing, the oxygen electrode including an electrode mixture which contains an oxygen reduction catalyst present in an electrochemically active amount, the mixture disposed on or within an at least partially electrically conductive interconnected substrate in at least partial electrical communication with the power module.

44. The electrochemical cell of claim 43 wherein the second electrode is exposed to ambient air.

45. The electrochemical cell of claim 36 wherein the first electrode includes inter-dispersing a hydrogen-absorbing material therewith.

46. The electrochemical cell of claim 45 wherein the hydrogen-absorbing material comprises a metal hydride.

47. The electrochemical cell of claim 36 wherein the transfer of the gaseous element is enhanced by chemical additions to the electrolyte.

48. The electrochemical cell of claim 36 wherein a rate or magnitude of side surface reactions is controllably altered by chemical additions to the electrolyte.

49. The electrochemical cell of claim 36 wherein a rate or magnitude of side surface reactions is controllably altered by adjustment of a cell pressure or temperature.

50. The electrochemical cell of claim 36 wherein a plurality of cells are electrically connected to each other in parallel or series to provide or receive an increased amount of current or voltage.

51. The electrochemical cell of claim 36 wherein the electrolyte is a basic electrolyte.

52. The electrochemical cell of claim 51 wherein the basic electrolyte comprises an alkali metal hydroxide.

53. The electrochemical cell of claim 52 wherein the basic electrolyte comprises potassium hydroxide.

54. The electrochemical cell of claim 51 wherein the basic electrolyte is at least one of a liquid or a gel or a solid.

55. The electrochemical cell of claim 36 wherein the electrolyte is an acidic electrolyte.

56. The electrochemical cell of claim 55 wherein the acidic electrolyte is at least one of a liquid or a gel or a solid.

57. The electrochemical cell of claim 36 wherein the electrolyte is circulated within the housing using a pump.

58. The electrochemical cell of claim 36 comprising a conductive matrix that includes at least one composite material assembly in contact with or comprising at least one of conductive foam, metal wire mesh, perforated metal foil, metal gauze, metallic foam or felt, and a perforated metallic sheet.

59. The electrochemical cell of claim 58 wherein the conductive matrix includes a conductive material additive comprising at least one of nickel, copper, carbon, silver, or alloys, mixtures, or compounds thereof.

60. The electrochemical cell of claim 58 wherein the conductive matrix includes at least one of sintering or welding constituents together.

61. The electrochemical cell of claim 36 wherein an operating temperature within the housing is periodically maintained between –50 degrees Celsius and 1000 degrees Celsius.

62. The electrochemical cell of claim 36 wherein an operating pressure within the housing is periodically maintained between 1 Bar and 2000 Bar.

63. The electrochemical cell of claim 36 wherein the housing further comprises a demister.

64. A method of gaseous element transfer comprising:

providing a composite material assembly including a base-material at least partially coated with a catalyst and at least partially permeable to the gaseous element, defining one or more hollow regions;

transferring a gaseous element into or out of the hollow region.

65. The method of claim 64 wherein the composite material assembly is a part of an electrochemical cell.

66. The method of claim 64 wherein the composite material assembly comprises hollow glass microspheres at least partially permeable to the gaseous element.

67. The method of claim 64 wherein the composite material assembly is at least partially disposed in an electrolyte.

68. The method of claim 64 wherein the transfer of gaseous element is facilitated with an electron source or sink.

69. The method of claim 64 wherein the permeability is controllably altered by chemical additions to the base-material.

70. The method of claim 64 wherein the permeability is controllably altered by operational changes to at least one of a pressure or a temperature about the composite material assembly.

71. The method of claim 64 wherein a rate of the gaseous transfer is enhanced by surface modifications to the coating.

72. The method of claim 64 wherein electrical energy is generated by transfer of the gaseous element from the one or more hollow regions and subsequent consumption of the gaseous element in electrochemical reactions.

73. The method of claim 64 wherein electrical energy is consumed by transfer of the gaseous element to the one or more hollow regions, subsequent to the gaseous element being generated in an electrochemical reaction.

74. The method of claim 65 wherein electrical energy and water are generated by the cell operating when the hydrogen and the oxygen are consumed in the electrochemical reactions upon being liberated from the hollow regions.

75. The method of claim 65 wherein electrical energy and water are consumed by operation of the electrochemical cell, at least one of hydrogen and oxygen being generated in an electrochemical reaction and accumulated in the one or more hollow regions.

76. The method of claim 64 wherein the composite material assembly is pressurized with gaseous hydrogen to an absolute pressure between 1 Bar and 2000 Bar.

77. The method of claim 64 wherein the composite material assembly is pressurized with gaseous oxygen to an absolute pressure between 1 Bar and 2000 Bar.

78. The method of claim 64 further comprising periodically maintaining an operating absolute pressure within electrolyte surrounding the composite material assembly between 1 Bar and 2000 Bar.

79. The method of claim 64 wherein periodically induced electrochemical reactions are controlled by periodic electrical communication between an electrode and a power module.